Physiotherapy 91 (2005) 119–126

Cervical erector spinae and upper trapezius muscle activity in children using different information technologies

Alison M. Greig*, Leon M. Straker, Andrew M. Briggs

School of Physiotherapy, Curtin University of Technology, Perth, Australia

Abstract

Objectives Researchers investigating the effects of computer use and the development of musculoskeletal disorders have mainly focused on the effects of prolonged muscle loading associated with postures assumed during computer use in the adult population. The objective of this study was to investigate the effects of different forms of old and new information technology (IT) on muscle activity levels in a paediatric population.
Design A $3 \times 3 \times 2$ mixed model design was used for this study.
Participants Thirty-two schoolchildren aged 4–17 years participated in this study.
Outcome measures Surface electromyography (EMG) data were collected from the left and right cervical erector spinae and upper trapezius muscles. Participants performed a 5-minutes reading task using the three IT types (book, laptop and desktop computer).
Results Cervical erector spinae and upper trapezius muscle activity levels were significantly higher when children used the laptop set-up ($P < 0.001$). The lowest muscle activity levels were found when children used the desktop set-up. Cervical erector spinae and upper trapezius muscle activities were found to be higher on the left side in the book set-up compared with higher right muscle activity levels in the computer set-ups ($P = 0.047$ and <0.001, respectively).
Conclusions The three IT types had different effects on cervical erector spinae and upper trapezius muscle activity, suggesting varying risks associated with different IT types. Activity levels were often above 5% maximum EMG (MEMG). As adult studies have linked activity levels greater than 5%MEMG with the development of musculoskeletal disorders, it seems that children are potentially at risk of replicating these adverse health reactions associated with adult IT use.

Keywords: Information technology (IT); Children; Musculoskeletal disorders

Introduction

Computers have become an essential tool for many adults in modern society and are now becoming widely used by children. The Australian Bureau of Statistics found that 95% of Australian school-aged children use computers (94% in school and 76% at home), with 74% of children using computers two or more times a week [1]. This increase in computer use by children has the potential to mimic the adult population, in which an association between computer use and the risk of developing pain and musculoskeletal disorders is known [2–5]. Associated risks may be direct, due to the physiological and biomechanical stresses associated with computer use, or indirect, due to sustained postures that may limit important musculoskeletal stimuli that are essential for normal musculoskeletal development. Other negative outcomes could include psychosocial factors such as an aversion towards computer use, decreased educational productivity and success, and decreased competency in a modern society [6]. As well as individual costs, there could be significant costs to the community arising from increased healthcare demands and decreased work performance. However, despite the suspected risks, little research has been conducted directly on children and computer use, and thus it is difficult to determine the actual health implications.

The majority of children access computers at school [1]. Classrooms were traditionally designed for old forms of

* Corresponding author. Present address: Centre for Health, Exercise and Sports Medicine, School of Physiotherapy, University of Melbourne, Vic. 3010, Australia. Tel.: +61 3 83444171; fax: +61 3 83444188.
E-mail address: a.greig@pgrad.unimelb.edu.au (A.M. Greig).

0031-9406/$ – see front matter © 2004 Chartered Society of Physiotherapy. Published by Elsevier Ltd. All rights reserved.
doi:10.1016/j.physio.2004.10.004

information technology (IT), mainly books. Available classroom space and workstation dimensions may not be suitable for new forms of IT, such as computers [7]. Recent studies have found an inappropriate user-workstation dimensional matching in classrooms and a marked lack of attention and commitment in the design of ergonomically suitable facilities for children to use at school [8–10]. To further complicate the situation, the design of computers is changing, with children now using both desktop and laptop computers. Laptops are designed to be portable, compact and lightweight; however, these attributes may come at a cost as the specialised features may force users into constrained postures, and therefore may introduce unique implications concerning physiological and postural effects compared with other IT types. The changing design of IT and increasing patterns of computer use by children both highlight the need to assess risk factors in order to develop appropriately designed workstation environments in order to minimise the potential for IT-related musculoskeletal disorders as seen in the adult population.

The underlying factors in the development of musculoskeletal disorders in adult computer users are thought to be multiple and complex, and include both physiological and psychological factors. Muscle activity and posture of the head, neck and shoulders are thought to be important physiological factors [11]. Research on adults has shown that the static neck muscle activities associated with prolonged computer use results in prolonged periods of heightened intramuscular pressures. Intramuscular homeostasis may be disrupted, and the day-to-day accumulation of damage may manifest as symptoms of discomfort and eventually lost productivity and increased risk of musculoskeletal injury [7,12]. The relatively high cumulative incidence of neck and back pain in adolescents may be related to sedentary and static postures, for example, those adopted during IT use [13–15].

A useful and measurable risk factor identified in the development of musculoskeletal disorders is static loading of muscles using electromyography (EMG) to measure the muscle activity as a percentage of maximum voluntary contraction (%MVC). Research has found that there is a high rate of musculoskeletal disorders among adult workers having to adopt postures that generated considerable static load in the neck and shoulders. ‘Static load level’ is defined as the 10th percentile of the level of muscle contraction during an observation period. Jonsson [16] made recommendations on load levels based on studies of muscular endurance; during constrained static work with a duration of 1 hour or greater, static load level should not exceed 2%MVC and must not exceed 5%MVC. This finding was supported by further research [2,17,18].

Although it is probable that the adverse physiological health reactions seen in adult computer users will be replicated in the paediatric population, to date, there has been little research directed at IT use by children, and there have been no studies investigating muscle activity in children using computers. Given the lack of data concerning muscle activity associated with computer use by children, the aim of this study was to measure neck muscle activity in children using old and new IT types at a standard school desk/chair set-up used in Australian schools. The research hypotheses were that there would be a difference in muscle activity between the three conditions (book, laptop and desktop), and that there would be interaction effects between IT type and age group based on differences in height between the age groups. The findings may enable a better understanding of potential factors associated with the development of negative health reactions related to IT use by children.

Method

Design

A $3 \times 3 \times 2$ mixed model design was used with one between-subject factor (age group: 4–8 years, 9–12 years and 13–17 years) and two within-subject factors (IT type: book, laptop and desktop; side: left and right). Muscle activity of the left and right cervical erector spinae (CES) and upper trapezius (UT) muscles was recorded as %MEMG (maximum electromyography output during a voluntary isometric contraction) whilst children performed a 5-minutes reading task for each of the three IT types in a laboratory setting.

Participants

Schoolchildren were recruited by notices placed in school newsletters and community newspapers in the Perth metropolitan area. The inclusion criteria required that the participants were of the appropriate age (4–17 years), had no known musculoskeletal condition or visual impairment, were right-handed in using the computer mouse, and satisfied the 5th–95th percentile for height and weight based on Australian normative data provided by the West Australian Department of Health. Of the 33 children recruited for the study, data from one subject were discarded due to excessive noise in the EMG signal. Of the remaining 32 children, there were 20 males and 12 females. There were nine children in the younger age group (4–8 years old), 11 children in the middle age group (9–12 years old) and 12 children in the older age group (13–17 years old). Participants were divided according to their age in years with the aim of reflecting typical school groupings and growth phases. Table 1 presents the

Table 1
Descriptive statistics according to age group division

Descriptor	Age group		
	Young (4–8 years)	Middle (9–12 years)	Old (13–17 years)
Males ($n = 20$)	5	7	8
Females ($n = 12$)	3	6	3
Weight (kg)–mean (S.D.)	23.8 (6.5)	39.0 (6.0)	63.8 (19.3)
Range	18.0–36.0	31.7–52.6	36.0–107.0
Height (cm)–mean (S.D.)	118.6 (11.3)	147.8 (4.7)	169.9 (9.4)
Range	99.0–133.0	142.0–159.0	151.0–186.0
Age (years)–mean (S.D.)	5.6 (1.5)	10.5 (1.3)	14.4 (1.1)